07094

27/FM
MULTIMETER

Operator's Manual

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AUGUST 1987
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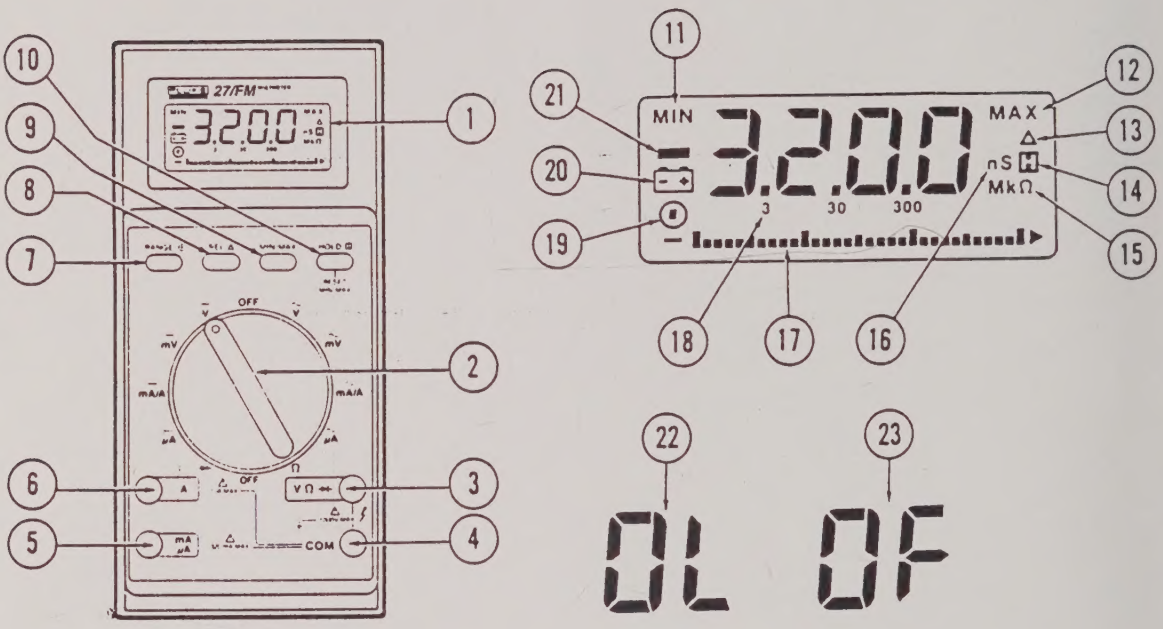
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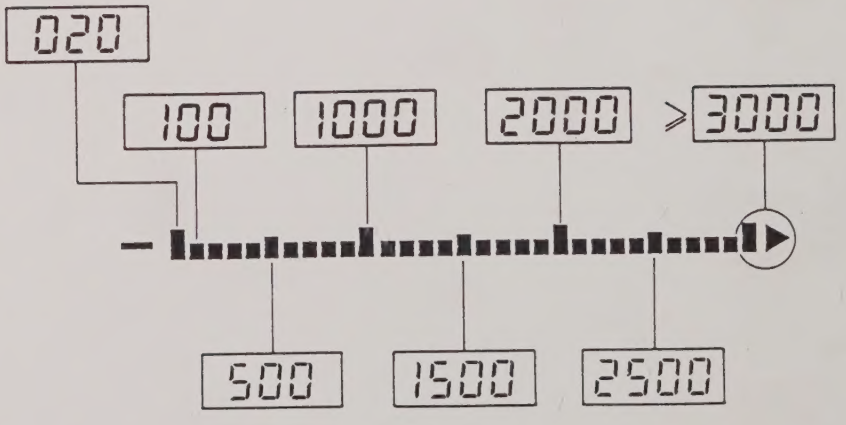
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CONTENTS

SECTION TITLE	PAGE
INTRODUCTION	1
UNPACKING THE INSTRUMENT	2
MULTIMETER SAFETY	2
BATTERY INSTALLATION AND REPLACEMENT	3
GETTING STARTED QUICKLY	4
POWER-UP OPTIONS AND TESTS	5
OPERATING FEATURES	5
MEASUREMENT TECHNIQUES AND CONSIDERATIONS	10
True RMS vs Average-Responding Meters	10
Measuring Voltage, AC/DC	10
Measuring Current, AC/DC	12
Current Measurement Error Calculations	12
Measuring Resistance	13
Diode and Continuity Testing	13
Measuring Conductance	14
Leakage Testing	14
USING THE ANALOG BAR GRAPH	15
Nulling	15
Contact Bounce	15
Checking Capacitors	16
Noisy Resistance Measurements	16
MAINTENANCE	16
General Maintenance	16
Tilt Stand Adjustment	17
Fuse Test	17
Fuse Replacement	17
SPECIFICATIONS	18

INTRODUCTION

The Fluke 27/FM Multimeter (hereinafter, also referred to as the "DMM" or "meter") is a true rms, digital multimeter that provides unsurpassed performance and operator safety in the most demanding working conditions. It meets MIL-T-28800 Type II, Class 2, Style A specifications for shock, vibration, humidity, and water resistance. The meter is powered by a 9V battery with a life of 750 hours.

The Fluke 27/FM combines the precision of a digital meter with the speed and versatility of an analog bar graph. Its 3200-count, digital display offers better resolution than a conventional 3-1/2 digit, 2000-count display. The 80K-6 High Voltage Probe that is shipped with the meter extends the voltage measurement capability of the meter to 6000V. A 1000:1 voltage

divider provides a high input impedance. Before using the 80K-6 probe, read the instruction sheet that accompanies it.

UNPACKING THE INSTRUMENT

The meter is shipped with a 80K-6 high voltage probe (and instruction sheet), TL70 test leads, two alligator clips (one red and one black), a 9V alkaline battery, this operator's manual, and a protective carrying case for meter and accessories. Contact the place of purchase immediately if anything is missing or damaged.

When reshipping the meter, use the original container. If this container is not available, we recommend that the instrument be surrounded by at least three inches of shock-absorbing material in the shipping container.

MULTIMETER SAFETY

Before using the meter, read the following safety information carefully. In this manual, the word **"WARNING"** is reserved for conditions and actions that pose possible hazard(s) to the operator; the word **"CAUTION"** means damage to the meter may occur. The symbols shown in Figure 1 are used internationally to denote the electrical functions and conditions indicated.

- Avoid working alone.
- Inspect the test leads for damaged insulation or exposed metal. Check test lead continuity. Damaged leads should be replaced.
- Be sure the DMM is in good operating condition. During the continuity test, a meter reading that goes from OL (overload) to 0 normally means the meter is working properly.
- Select the proper function and range for your measurement.
- ⚠ ▣ When servicing, use only specified replacement parts.

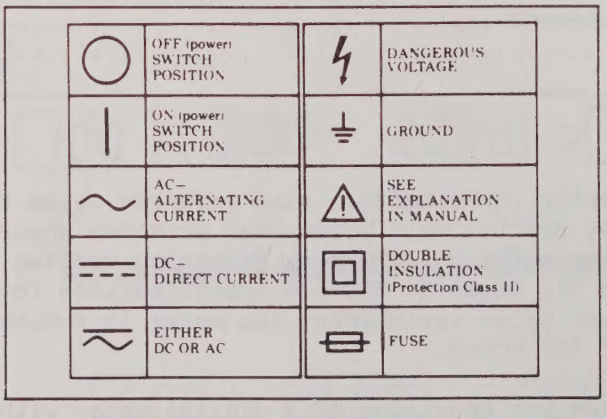

Figure 1. International Electrical Symbols

WARNING

TO AVOID ELECTRICAL SHOCK OR DAMAGE TO THE METER, DO NOT APPLY MORE THAN 1000V BETWEEN ANY TERMINAL AND EARTH GROUND.

WARNING

TO AVOID ELECTRICAL SHOCK, USE CAUTION WHEN WORKING ABOVE 60V DC OR 25V AC RMS. SUCH VOLTAGES POSE A SHOCK HAZARD.

- Disconnect the live (hot) test lead before disconnecting the common test lead.
- Follow all safety procedures for equipment being tested. Disconnect the input power and discharge all high-voltage capacitors through a protective impedance before testing in the Ω and ⏐⏐⏐ ⇥⊢ functions.
- When making a current measurement, turn the power off before connecting the DMM in the circuit.
- Check DMM fuses before measuring transformer secondary or motor winding current. An open fuse may allow high voltage build-up, which is potentially hazardous.

WARNING

TO AVOID ELECTRICAL SHOCK, REMOVE THE TEST LEADS AND ANY INPUT SIGNALS BEFORE REPLACING THE BATTERY OR FUSES.

BATTERY INSTALLATION AND REPLACEMENT

The meter is powered by a single 9V battery (NEDA 1604, 6F22, or 006P). Referring to Figure 2, use the following procedure to install (and replace) the battery.

1. Disconnect test leads from any live source, turn the rotary switch to OFF, and remove the test leads from the input terminals.
2. Lift the instrument stand on the back of the Fluke 27/FM, then remove the four (#6 X 32) screws from the battery cover.
3. Pull the battery cover straight out from the back of the meter. (A coin-slot in the side of the battery cover facilitates removal.)
4. Snap the battery connector to the terminals on the battery, then slide the battery into the battery holder. Slip each battery lead into the slot in the holder as shown in Figure 2.
5. Insert the battery holder/cover into the meter, then start the four screws removed in step 2. Press firmly on the battery cover while tightening the screws in a diagonal pattern.

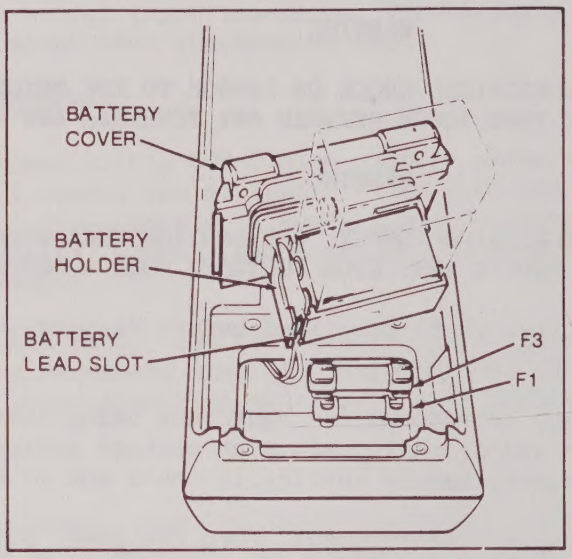

Figure 2. Battery Installation and Replacement

GETTING STARTED QUICKLY

NOTE

Read "MULTIMETER SAFETY" (above) before using the DMM.

Familiarize yourself with the layout of the meter, taking note of the location of the input terminals, rotary switch, push buttons and display. After doing so, you probably already have a good idea how to use the meter to take basic voltage, current, and resistance measurements. Simply:

1. Insert the test leads in the appropriate input terminals, and set the rotary switch to the desired position.

2. To select additional functions and modes, press the appropriate pushbuttons above the rotary switch.

   - To operate the MIN/MAX and [manual] RANGE features: press to select, press again to increment, and press and hold for two seconds to exit.

   - To operate the [Touch] HOLD and REL[ative] features: press to activate and press again to exit.

   An annunciator lights on the display to indicate that a function has been selected.

3. To take a measurement, make the proper contacts with the test lead probes, inserting the meter in the circuit (in series for current or in parallel for voltage measurements). Read the measurement on the display. If you did not manually select a range (by using the RANGE button), the range which provides the best resolution is automatically selected for you.

This simple procedure will allow you to take basic measurements. However, to use your meter to full advantage, read the remainder of this manual.

POWER-UP OPTIONS AND TESTS

To power up the meter, turn the rotary function selector switch from OFF to any position. The meter then performs a selftest and battery check. During the selftest all display segments are switched on for about 1 second, then the display blanks. The meter is now operational.

The battery test performed at power up (and each time you select a different function with the rotary switch) determines if the voltage is below 6.3V. If it is, the [-+] annunciator comes on and remains on until the battery recovers or is replaced (i.e, voltage is above the above the 6.3V.)

The meter powers up in the autorange mode. In autorange, the meter automatically selects the appropriate range for the measurement being taken. If the function selected has only one range, then the ⊙ symbol is displayed. The operating range is indicated by the decimal point position and range indicator in the display, and in the Ω function by the presence of the M or k annunciators. There is no annunciator for the autorange mode. The meter is in autorange unless the manual range annunciator is on.

Manual ranging can be selected at power up by pressing and holding the RANGE button while the function switch is moved from OFF to any ON position. To return to the autorange mode, press RANGE for approximately two seconds.

If the HOLD push button is pressed while the function switch is moved from OFF to any ON position, automatic updates in the Touch-Hold* mode are defeated and the Touch-Hold mode only displays a new reading when HOLD button is pressed. This is useful when you want to take a reading at a specific time and hold it.

OPERATING FEATURES

The meter is operated from the front panel. All operating features and functions are described below and are keyed by number to the illustration inside the front cover.

(1) Digital Display:

3200-count, liquid crystal display (LCD) with automatic decimal point positioning. Updated two times per second. When the meter is first turned on, all display segments appear while the instrument performs a brief power-up self-test.

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* Touch-Hold is a trademark of the John Fluke Manufacturing Co., Inc.

(2) Function Selector Rotary Switch:

To select one of ten functions (or OFF), listed below, turn the function selector rotary switch to the position for the desired function. Refer to Table 1 for input terminals and limits and to specifications in Table 3 for available ranges.

- V⎓ — Volts dc
- mV⎓ — Millivolts dc
- V~ — Volts ac
- mV~ — Millivolts ac
- Ω — Ohms (resistance), also conductance (1/ohms) in nanosiemens (nS)
-))) ⊣⊢ — Continuity or diode test
- mA/A~ — Milliamps or amperes ac
- μA⎓ — Microamps dc
- mA/A⎓ — Milliamps or amperes dc
- μA~ — Microamps ac

Table 1. Input Terminals and Limits

FUNCTION	INPUT TERMINALS Red Lead	Black Lead	MIN DISPLAY READING	MAX DISPLAY READING	MAXIMUM INPUT
V⎓ V~	V Ω ⊣⊢	COM	0.001V	1000V	1000V
mV⎓ mV~	V Ω ⊣⊢	COM	0.1 mV	320.0 mV	500V
Ω	V Ω ⊣⊢	COM	0.1Ω	32.00 MΩ	500V
(nS)	V Ω ⊣⊢	COM	0.01 nS	32.00 nS	500V
))) ⊣⊢	V Ω ⊣⊢	COM	0.001V	2.08V	500V
mA/A⎓ mA/A~	A	COM	0.01A	20.00A*	10A* 600V
	mA μA	COM	0.01 mA	320.0 mA	320 mA 600V
μA⎓ μA~	mA μA	COM	0.1 μA	3200 μA	320 mA** 600V**

*10A continous, 20A for 30 seconds maximum

**320mA continous, 1A for 30 seconds maximum

(3) **V Ω →+** **Volt, Ohms, Diode Test Input Terminal:**

Input terminal used in conjunction with the volts, mV (ac or dc), ohms, or diode test position of the function selector rotary switch.

(4) **COM** **Common Terminal:**

Common or return terminal used for all measurements.

(5) **mA μA** **Milliamp/Microamp Input Terminal:**

Input terminal used for current measurements up to 320 mA (ac or dc) with the function selector rotary switch in the mA or uA position.

(6) **A** **Amperes Input Terminal:**

Input terminal used for current measurements up to 10A continuous (20A for 30 seconds) with the function selector rotary switch in the mA/A position (ac or dc).

(7) **RANGE ⊙** **Manual Range Mode Pushbutton:**

Press once to enter manual range mode, press again to increment range, press and hold for 2 seconds to return to autorange. Meter returns to autorange if the function selector is switched to any other position. There is no autorange annunciator; absence of the manual range annunciator indicates the meter is in autorange. If RANGE is depressed and held for the duration of the selftest, while the function switch is moved from OFF to any ON position, manual ranging will be selected in all functions.

(8) **REL Δ** **Relative Mode Pushbutton:**

Press momentarily to enter the Relative mode and store the displayed reading. The display will read zero. Press again to update the stored digital reading. Press and hold for 2 seconds to exit the Relative mode. The Relative mode stores a digital reading and displays the change (difference) between the stored reading and any following reading. For example, if the stored reading is 15.00V and the present reading is 14.10V, the display will indicate -0.90V. The analog bar graph continues to display the actual reading (14.10V). If the difference exceeds 3999 counts (without overloading the input), OF (overflow) is displayed. The Relative mode selects manual ranging; changing ranges automatically exits the Relative mode.

(9) **MIN/MAX** **Mode Pushbutton:**

Press momentarily to enter MIN/MAX mode, press again to toggle between MIN and MAX indications. Press and hold for 2 seconds to exit MIN/MAX mode. The meter stores the minimum and maximum digital readings, and will display either reading as selected by the operator. Press the HOLD/RESET button to reset the MIN/MAX readings to the present input.

The MIN/MAX mode selects manual ranging; use a range that can record the maximum anticipated input. Range changes reset previously recorded MIN/MAX readings. Exiting the MIN/MAX mode does not reset the previously recorded readings unless the range or function is changed. The MIN/MAX mode overrides the Touch-Hold mode.

(10) **HOLD H** **Touch-Hold Mode Pushbutton:**

Press momentarily to enter Touch-Hold mode. In Touch-Hold, the meter captures a stable measurement and holds it on the display. The operator can watch the probes while taking measurements in difficult or hazardous circuits, then look at the display when convenient. The meter beeps and the display is automatically updated each time a new, stable measurement is made. Press momentarily to manually update reading. Press and hold for 2 seconds to exit Touch-Hold mode. If HOLD is depressed and held for the duration of the selftest, while the function switch is moved from OFF to any ON position, the Touch-Hold mode will only update to a new reading when the HOLD button is pressed. (Automatic Touch-Hold updates are defeated.) This is useful when you want to take a reading at a specific time and hold it.

(11) **MIN** **Minimum Value Annunciator:**

Indicates that the meter is in the MIN/MAX recording mode, and the value displayed is the minimum digital reading taken since reset or since entering MIN/MAX. Refer to item 9 for operation.

(12) **MAX** **Maximum Value Annunciator:**

Indicates that the meter is in the MIN/MAX recording mode, and the value displayed is the maximum digital reading taken since reset or since entering MIN/MAX. Refer to item 9 for operation.

(13) **Δ** **Relative Value Annunciator:**

Indicates that the meter is in the Relative mode and that the value displayed is relative (the difference between the present measurement and the previously stored reading). Refer to item 8 for operation.

(14) **H** **Touch-Hold Mode Annunciator:**

Displayed when the Touch-Hold mode is in use. Refer to item 10 for operation.

(15) **MkΩ** **Resistance Annunciators:**

The appropriate annunciator (M, k, or Ω) is displayed for the resistance range in use.

(16) **nS** **Conductance Range Annunciator (nS):**

Top range of the resistance function is the conductance range. Displays conductance in nS (nanosiemens). 1000/nS converts to MΩ. (Example: 2 nS converts to 500MΩ.) Use for measuring resistance above 32MΩ. Select Ω, open test leads, press RANGE button twice. (Refer to item 7 for manual range operation.)

(17) **Analog Bar Graph Display:**

Analog representation of input. Composed of 31 segments which illuminate starting from the left as the input increases. (See display inside front cover.) A minus sign (▬) is displayed for reverse-polarity inputs. Updated 25 times per second.

(18) **Decimal Point/Range Indicator:**

Decimal point position and the digits (3, 30, 300) under the decimal point indicate the range in use.

(19) **Manual Range Annunciator:**

Displayed in the Manual Range mode or if the selected function has only one range. Absence of the indicator implies autorange mode in use. The meter powers-up in autorange. In autorange, the meter automatically selects the measurement range. Refer to item 7 for operation.

(20) **Low Battery Annunciator:**

At least 40 hours of battery life remain when first displayed. Battery voltage is tested each time the function switch is moved to a new position.

(21) **Negative Polarity Annunciator:**

Automatically indicates negative inputs.

(22) **OL** **Overload Indication:**

Indicates that the input is too large for the input circuitry. (The location of the decimal point depends on the measurement range.)

(23) **OF** **Overflow Indication:**

Indicates that the calculated difference in the Relative mode is too large to display (>3999 counts) and that the input is not overloaded.

(24) **Beeper (not illustrated):**

The beeper emits beeps, clicks, or a continuous tone. It is used for audible indication in the diode test mode, when operating the push buttons, and when a new reading is displayed in the Touch-Hold mode.

MEASUREMENT TECHNIQUES AND CONSIDERATIONS

The following measurement techniques and considerations will assist you in using your meter safely and effectively.

True RMS vs Average-Responding Meters

One of the most useful features of the Fluke 27/FM is the direct measurement of true rms or effective ac voltages and ac currents. Mathematically, rms is defined as the square root of the sum of the squares of the ac and dc components. In physical terms, rms is equivalent to the dc value that dissipates the same amount of heat in a resistor as the original waveform. The reason that rms is valuable is that it greatly simplifies the analysis of complex ac signals. Since rms is the dc equivalent to the original waveform, it can be used in the relationships derived from Ohm's law (E = I x R), and it provides a reliable basis for comparing dissimilar waveforms.

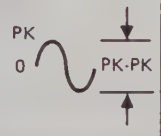
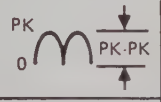
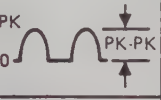
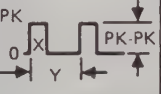
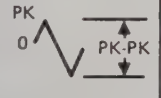
Most meters today have average-responding ac converters rather than true rms ac converters. Usually the gain in average-responding meters is adjusted so that the reading gives the rms value, provided the input signal is a harmonic-free sinusoid. However, if the signal is not sinusoidal, the average-responding meter does not give correct rms readings.

The Fluke 27/FM actually calculates the rms value through analog computation. This means that readings are accurate rms values not only for harmonic-free sinusoids, but also for mixed frequencies, modulated signals, square waves, sawtooths, 10%-duty-cycle rectangular pulses, etc.

Figure 3 shows some common waveforms and a comparison of the readings displayed by your true rms meter and average-responding meters. Figure 3 also illustrates the relationship between ac and dc measurements for ac-coupled meters. For example, consider the first waveform, a 1.414V (0-pk) sine wave. Both true rms and the rms-calibrated average-respondings meters display the correct rms reading of 1.000V (the dc component equals 0). However, consider the 1.414V (0-pk) rectified square wave. Both types of meters correctly measure the dc component (0.707V). Only the true rms meter correctly measures the ac component (0.707V). The average-responding meter measures 0.785V, which amounts to a 5.6% error in the total rms measurement calculated from the ac and dc components. Since average-responding meters have been in use for so long, you may have accumulated test or reference data based on them. The conversion factors in Figure 3 should help you convert between the two measurement methods.

Measuring Voltage, AC/DC

The multimeter features five ac voltage ranges and five dc voltage ranges. All ranges present an input impedance of approximately 10 megohms in parallel with less than 100 pF. Measurement errors, due to circuit loading, can result when making either ac or dc voltage measurements on circuits with high source resistance. However, in most cases the error is negligible (0.1% or less) if the measurement circuit source resistance is 10 kilohms or less. If circuit loading does present a problem, the percentage of error can be calculated using the appropriate formula from Figure 4.

AC-COUPLED INPUT WAVEFORM	PEAK VOLTAGES		METERED VOLTAGES			DC AND AC TOTAL RMS
			AC COMPONENT ONLY		DC COMPONENT ONLY	TRUE RMS = $\sqrt{ac^2 + dc^2}$
	PK-PK	0-PK	RMS CAL*	27/FM		
SINE 	2.828	1.414	1.000	1.000	0.000	1.000
RECTIFIED SINE (FULL WAVE) 	1.414	1.414	0.421	0.435	0.900	1.000
RECTIFIED SINE (HALF WAVE) 	2.000	2.000	0.764	0.771	0.636	1.000
SQUARE	2.000	1.000	1.110	1.000	0.000	1.000
RECTIFIED SQUARE	1.414	1.414	0.785	0.707	0.707	1.000
RECTANGULAR PULSE  $D = X/Y$ $K = \sqrt{D - D^2}$	2.000	2.000	2.22K	2K	2D	$2\sqrt{D}$
TRIANGLE SAWTOOTH 	3.464	1.732	0.960	1.000	0.000	1.000

* RMS CAL IS THE DISPLAYED VALUE FOR AVERAGE RESPONDING METERS THAT ARE CALIBRATED TO DISPLAY RMS FOR SINE WAVES

Figure 3. Waveform Conversion

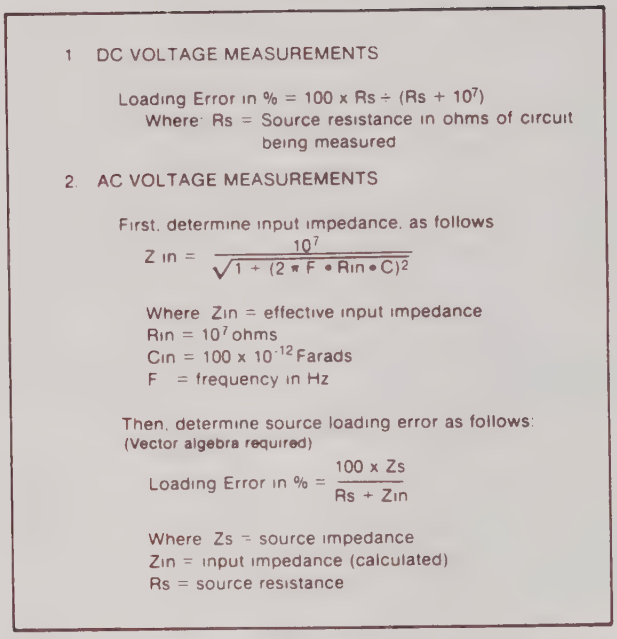

1 DC VOLTAGE MEASUREMENTS
Loading Error in % = 100 x Rs ÷ (Rs + 10^7)
Where: Rs = Source resistance in ohms of circuit being measured
2. AC VOLTAGE MEASUREMENTS
First, determine input impedance, as follows
Z in = 10^7 / √(1 + (2 π F • Rin • C)^2)
Where Zin = effective input impedance
Rin = 10^7 ohms
Cin = 100 x 10^-12 Farads
F = frequency in Hz
Then, determine source loading error as follows:
(Vector algebra required)
Loading Error in % = 100 x Zs / (Rs + Zin)
Where Zs = source impedance
Zin = input impedance (calculated)
Rs = source resistance

Figure 4. Voltage Measurement Error Calculations

When measuring voltages above 320V in Touch-Hold mode, use manual ranging to minimize readings of stray voltages.

Measuring Current, AC/DC

WARNING

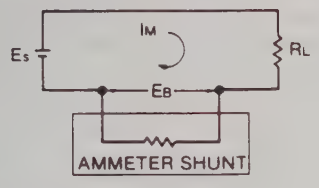
INSTRUMENT DAMAGE AND OPERATOR INJURY MAY RESULT IF THE FUSE BLOWS WHILE CURRENT IS BEING MEASURED IN A CIRCUIT WHICH EXHIBITS AN OPEN CIRCUIT VOLTAGE GREATER THAN 600V. DO NOT ATTEMPT AN IN-CIRCUIT CURRENT MEASUREMENT WHERE THE POTENTIAL IS GREATER THAN 600V.

The multimeter features five ac current ranges and five dc current ranges. All current ranges are fuse protected. If a fuse opens, refer to the fuse replacement procedures in the "MAINTENANCE" section of this manual.

Current Measurement Error Calculations

In an ac or dc current measurement, the voltage developed across the meter's terminals is called burden voltage. The burden voltage for a full-scale input is given for each range in Table 3 (specifications). The burden voltage can affect the accuracy of a current measurement if the current source is unregulated and the terminal resistance represents a significant portion (1/1000 or more) of the source resistance. If burden voltage does present a problem, the percentage of error can be calculated using the

formula in Figure 5. Approximate terminal resistances for the current ranges are: 0.05 ohms for A, 5.5 ohms for mA, and 500 ohms for uA.



E_S = Source voltage
R_L = Load resistance + Source resistance
I_M = Measured current (display reading in mA)
E_B = Burden voltage (calculated), i.e., Display reading expressed as a % of full-scale ($100 \times \frac{\text{READING}}{\text{FULL-SCALE}}$) times full-scale burden voltage for selected range. See Table:

RANGE	TYPICAL BURDEN VOLTAGE
320 μA	0.16V
3200 μA	1.6V
32 mA	.18V
320 mA	1.8V
10A	0.5V

Maximum current error due to Burden Voltage

$$\text{in \%} = 100 \times \frac{E_B}{E_S - E_B}$$

$$\text{in mA} = \frac{E_B \times I_M}{E_S - E_B}$$

Example. $E_S = 15V$, $R_L = 50\Omega$, $I_M = 270$ mA.

$$E_B = 100 \times \frac{270}{320} \times 1.8 \text{ (from Table)}$$

$$84.4\% \times 1.8 = 1.519V$$

$$\text{Error in \%} = 100 \frac{1.519}{15 - 1.519} = 100 \frac{1.519}{13.481} = 11.3\%$$

Increase displayed current by 11.3% to obtain true current

$$\text{Error in mA} = \frac{1.519 \times 270}{15 - 1.519} = \frac{410}{13.481} = 30.41 \text{ mA}$$

Increase displayed current by 30 mA to obtain true current.

Figure 5. Current Measurement Error Calculations

Measuring Resistance

CAUTION

Turn test circuit power off and discharge all capacitors before attempting in-circuit resistance measurements.

The multimeter features six resistance ranges and a conductance range. All ranges employ a two-wire measurement technique. As a result, test lead resistance may influence measurement accuracy on the 320-ohm range. To determine the error, short the test leads together and read the lead resistance. Correct the measurement by subtracting the lead resistance from the measurement, or use the Relative (REL Δ) mode to zero the display. The error is usually 0.1 to 0.2 ohms for a standard pair of test leads.

Some in-circuit resistance measurements can be made without removing diodes and transistors from the circuit. The full-scale measurement voltage produced on ranges below 32 megohms does not strongly forward bias silicon diodes or transistor junctions. Use the highest range you can (except 32 megohm) to minimize the possibility of turning on diodes or transistor junctions. Full scale measurement voltage in the 32-megohm range does strongly forward bias a diode or transistor.

Diode and Continuity Testing

In diode test, there is only one range: 0 to +2.08 volts. Voltage is developed across the component(s) under test by a test current output from

the multimeter. Voltages greater than 2.08V or open test leads produce an overload (OL) condition. Negative inputs produce a negative indication (they are not suppressed). In the diode test function ( ))) →), the beeper produces a continuous tone if the input is less than 0.1V, and the beeper beeps once when the input descends through a 0.7V threshold.

Audible continuity testing is also performed with the function selector switch in the ( ))) →) position. A continuous tone sounds for resistances below approximately 150 ohms. An intermittent connection produces erratic beeps, and can be a valuable troubleshooting aid. Erratic beeps can also occur, due to environmental noise, if a test value is very close to the threshold (150 ohms). Test resistances from approximately 150 ohms to 1000 ohms produce a short tone similar to a forward biased diode. Test resistances less than approximately 20 kilohms will produce an on-scale reading.

Measuring Conductance

Measuring conductance is performed with the function selector switch in the ohms (Ω) function. The conductance range can only be entered when the meter is in the manual ranging mode. The conductance range can be used both to measure conductance (1/ohms, the inverse of resistance) and to measure very high resistances (greater than 32 megohms).

High value resistance measurements are susceptible to induced noise, and may require careful shielding. Conductance measurements are displayed in nanosiemens (nS). Calculate megohms by dividing 1000 by the nanosiemens displayed (1000/nS is equivalent to megohms). Example: 2 nS converts to 500 megohms (1000/2).

Leakage Testing

The conductance range effectively extends the resistance measurement capability of the multimeter to the point where it can provide useful leakage measurements on passive components. For example, the operator can detect leaky diodes, cables, connectors, printed circuit boards, etc. In all cases, the test voltage is less than 2V dc.

Leakage testing on purely resistive components such as cables and printed circuit boards is straightforward. Select the ohms function and manually increment the range to conductance (nS). Connect the test leads to the test points on the unit under test, and read the leakage in terms of conductance.

NOTE

In the conductance range, there is normally a small residual reading with open test leads. To ensure accurate measurements, connect clean test leads to the multimeter and (with the leads open) read the residual leakage in nanosiemens. Correct subsequent measurements by subtracting the residual from the readings. This can be done automatically using the Relative mode (REL Δ).

Diode leakage tests require that the diode junction be reverse biased when being measured. This is accomplished by connecting the anode of the diode to the COMMON input terminal and the cathode (ring) of the diode to the V Ω ⊣⊢ input terminal. Leakage at the test voltage being applied can then be read in terms of conductance.

High-voltage stacked diode assemblies can usually be tested for forward and reverse resistance changes using conductance. These assemblies typically have such high forward voltage drops that the diode test or resistance modes cannot test them.

USING THE ANALOG BAR GRAPH

The analog bar graph functions like the needle on an analog meter without the mechanical overshoot of movements.

The bar graph is especially useful for peaking and nulling, and observing rapidly changing inputs. Because bar graph response time is fast and precise, it can be used to make approximate adjustments quickly. The 3200-count digital display can then be used for final adjustment.

The analog bar graph can also be used for some limited diagnostic purposes. In situations where rapidly fluctuating signal levels make the digital display useless, the bar graph is ideal. Like the needle on a Volt-ohm milliammeter (VOM), the analog bar graph excels at displaying trends, or slowly changing signals. In addition, in the Autorange mode, you can monitor signal change through changing ranges. Many diagnostic routines using the bar graph require practice. You will usually be looking for good or bad signal patterns that occur over some span of time. Noisy resistance measurements, for instance, create such patterns. Therefore, familiarity with analog bar graph response and movement is necessary to accurately interpret a signal pattern. Compare the bar graph response when making measurements on a known-good unit to the bar graph response when making measurements on a faulty unit.

Nulling

The DMM's bar graph is ideal for nulling adjustments. As an adjustment approaches zero, fewer bar graph segments are displayed, until no bar graph segments are displayed. The − annunciator flickers when the input level is within 10 counts of zero. The flickering null indication is displayed every time the input approaches zero or swings from one polarity to the other. Watch for the − annunciator indication, then reverse the direction of the adjustment when the polarity sign is displayed. In one or two passes, a near-zero input level is possible, then the digital display can be used for exact zero adjustment.

Contact Bounce

Relay contacts may begin to bounce open when subject to vibration. Testing for this problem is a routine troubleshooting practice for many types of equipment. Since the bounce problem will worsen as the relay fatigues, early diagnosis is important.

Using the Bar Graph

The bar graph will display at least one segment when the contact opens. The bar graph can detect contact bounce as brief as 0.2 ms, while most analog needle movements require a 3 ms opening before they will respond.

Checking Capacitors

With the meter set to the resistance function, the analog bar graph can be used (even in the autoranging mode) to check capacitors. As a capacitor is placed across the inputs, the analog bar graph quickly shortens, then rapidly down-ranges, depending on the size of the capacitor. As the capacitor charges, the bar graph slowly extends back to its full 31-segment length, up-ranging if necessary. For capacitors as small as 0.02 uF, only the 30-megohm range is involved, the last few segments blink off, then back on.

In a fixed range (using manual range mode), the time it takes for the bar graph to extend from zero to full scale indicates the approximate capacitance value. Table 2 gives typical capacitance values for various charge times on different resistance ranges. For very small capacitors, use the conductance (1/ohm nS) mode.

Table 2. Capacitance vs. Time to Full Scale

Resistance Range	320Ω	3.2kΩ	32kΩ	320kΩ	3.2MΩ	32MΩ
Capacitance Value						
10,000 μF	4 sec	33 sec	5 min	ext	ext	ext
1,000 μF	blink	4 sec	30 sec	ext	ext	ext
100 μF	nil	blink	4 sec	32 sec	ext	ext
10 μF	nil	nil	blink	4 sec	30 sec	ext
1 μF	nil	nil	nil	blink	3 sec	19 sec
0.1 μF	nil	nil	nil	nil	blink	2 sec
0.02 μF	nil	nil	nil	nil	nil	blink
ext = extended time, nil = no indication						

Noisy Resistance Measurements

Your Fluke meter will tolerate ac noise far better than the usual DMM. Readings of 2-kilohms can be obtained even in the presence of 1V ac noise. Readings of 1 megohm may be obtained with up to 2V ac noise. The noise appears as about 50 counts of change and an oscillating bar graph.

MAINTENANCE

General Maintenance

Replaceable parts are listed below:

PART	FSCM	PART NO.	NSN
F1-Fuse, Catridge 1A/600V	71400	BBS-1	5920-00-615-3781
F3-Fuse 15A/600V	71400	KTK-15	5920-00-064-2374
Lead, Test	89536	654053	6625-01-220-5608
Battery, 9V Alkaline, NEDA 1604A	-----	------	-----

Clean the case with a damp cloth and detergent; do not use abrasives or solvents.

Have the meter calibrated by a qualified technician once a year to ensure specified performance.

Tilt Stand Adjustment

To use the tilt stand as a handle, lift the stand slightly (about 1 inch or 2.5 cm), pull the ends out, and insert the ends in the alternate set of holes.

Fuse Test

Use the following procedure to test internal fuses:

1. Turn the function selector switch to the Ω position.
2. Connect a test lead from the V Ω ⊣⊢ input terminal to the A input terminal.
3. The display should indicate between 0.1 ohm and 0.3 ohm. This tests F3 (15A, 600V fast).
4. Move one end of the test lead from the A input terminal to the mA/uA input terminal.
5. The display should indicate between 4.5 ohms and 6.5 ohms. This tests F1 (1A, 600V fast).
6. If either of the above display indications is OL (overload), replace the appropriate fuse.

Fuse Replacement

WARNING

TO PREVENT DAMAGE OR INJURY, REPLACE A FUSE WITH ONE OF THE SAME SIZE AND AMP/VOLT RATINGS.

Use the following procedure to check or replace the multimeter's fuses. (Refer to Figure 2, if necessary).

1. Perform steps 1 through 3 of the battery installation and replacement procedure.
2. Remove the defective fuse (or check continuity through the suspected fuse).
3. Replace the defective fuse(s) with a new fuse of the same size and rating.
4. Reinstall the battery cover/holder as described in step 5 of the battery installation and replacement procedure.

SPECIFICATIONS

Table 3. Specifications

FUNCTION	RANGE	RESOLUTION	ACCURACY*		
V⎓	3.200V	0.001V	+/-(0.1%+1)		
	32.00V	0.01V	+/-(0.1%+1)		
	320.0V	0.1V	+/-(0.1%+1)		
	1000V	1V	+/-(0.1%+1)		
mV⎓	320.0 mV	0.1 mV	+/-(0.1%+1)		
Ω	320.0Ω	0.1Ω	+/-(0.3%+2)		
	3.200 kΩ	0.001 kΩ	+/-(0.25%+1)		
	32.00 kΩ	0.01 kΩ	+/-(0.25%+1)		
	320.0 kΩ	0.1 kΩ	+/-(0.25%+1)		
	3.200 MΩ	0.001 MΩ	+/-(0.25%+1)		
	32.00 MΩ	0.01 MΩ	+/-(1%+1)		
(nS)	32.00 nS	0.01 nS	+/-(2%+10) typical		
))) ⊣⊢	2.000V	0.001V	+/-(1%+1) typical		
	For continuity tests, the beeper emits a continuous tone at test resistance below approximately 150Ω				
V~			20 Hz-40 Hz	40 Hz-1 kHz	1 kHz-5 kHz
	3.200V	0.001V	+/-(1.5%+5)	+/-(0.5%+5)	+/-(5%+5)
	32.00V	0.01V	+/-(1.5%+5)	+/-(0.5%+5)	+/-(5%+5)
	320.0V	0.1V	+/-(1.5%+5)	+/-(0.5%+5)	+/-(5%+5)
	1000V	1V	+/-(1.5%+5)	+/-(0.5%+5)	+/-(5%+5)
mV~	320.0 mV	0.1 mV	+/-(1.5%+5)	+/-(0.5%+5)	+/-(5%+5)

* Accuracy is specified as +/-([% of reading] + [number of least significant digits]).

Basic electrical accuracy is specified from 18 to 28°C, at a relative humidity of up to 95%, for one year after calibration.

Within a single ac range, accuracy is specified between 5 and 100% of full range. AC conversion method is AC coupled, true rms responding to signals whose crest factor is 3:1 or less.

Table 3. Specifications (cont)

FUNCTION	RANGE	RESOLUTION	ACCURACY	TYPICAL BURDEN VOLTAGE
mA/A	32.00 mA	0.01 mA	+/-(0.75%+2)	6 mV/mA
	320.0 mA	0.1 mA	+/-(0.75%+2)	6 mV/mA
	10.00 A	0.01A	+/-(1.75%+2)	50 mV/A
μA	320.0 uA	0.1 uA	+/-(0.75%+2)	0.5 mV/uA
	3200 uA	1 uA	+/-(0.75%+2)	0.5 mV/uA
~ mA/A	32.00 mA	0.01 mA	+/-(1.5%+5)	6 mV/mA
40 Hz-1 kHz#	320.0 mA	0.1 mA	+/-(1.5%+5)	6 mV/mA
	10.00 A	0.01A	+/-(2.5%+5)	50 mV/A
~ μA	320.0 uA	0.1 uA	+/-(1.5%+5)	0.5 mV/uA
40 Hz-1 kHz#	3200 uA	1 uA	+/-(1.5%+5)	0.5 mV/uA

FUNCTION	OVERLOAD PROTECTION	INPUT IMPEDANCE (nominal)	COMMON MODE REJECTION RATIO (1 kΩ unbalance)	NORMAL MODE REJECTION
V	1000V rms	10 MΩ in // with <100 pF	>120 dB at dc, 50 Hz, or 60 Hz	>60 dB at 50 Hz or 60 Hz
mV	750V rms	10 MΩ in // with <100 pF	>120 dB at dc, 50 Hz, or 60 Hz	>60 dB at 50 Hz or 60 Hz
~ V	1000V rms	10 MΩ in // with <100 pF (ac coupled)	>60 dB, dc to 60 Hz	
~ mV	750V rms	10 MΩ in // with <100 pF (ac coupled)	>60 dB, dc to 60 Hz	

Between 20 and 40 Hz, ac current ranges to 320 mA are specified to an accuracy of +/-(2%+5), and 10A ac current is specified to +/-(3%+5).

Table 3. Specifications (cont)

	OVERLOAD PROTECTION	OPEN CIRCUIT TEST VOLTAGE	FULL SCALE VOLTAGE	
			Up to 3.2 MΩ	32 MΩ or nS
Ω	750V rms	<2.8V dc	<420 mV dc	<1.3V dc

Fuse Protection	1A 600V Fast, 15A 600V Fast
Maximum Input Voltage	1000V Between any Terminal and Earth Ground
Digital Display	3200 counts, updates 2/sec
Analog Display	31 segments, updates 25/sec
Operating Temperature	-15°C to 55°C, to -40°C for 20 minutes when taken from 20°C
Storage Temperature	-55°C to 85°C
Temperature Coefficient	0.1 x (specified accuracy)/°C (<18°C or >28°C)
Relative Humidity	0% to 95% (0°C to 35°C) 0% to 70% (35°C to 55°C)
Battery Type	9V, NEDA 1604 or 6F22 or 006P
Battery Life	750 hrs typical
Shock, Vibration and Water Resistance	Per MIL-T-28800 for a Style A, Class 2 Instrument
Size (H x W x L)	2.2 in x 3.75 in x 8 in (5.6 cm x 9.5 cm x 20.3 cm)

Table 3. Specifications (cont)

Weight	1.6 pounds (0.75 kg)
Safety	Protection Class II per IEC 348 and ANSI C39.5
80K-6 High Voltage Probe	Voltage Range ..... 0 to 6 kV, dc or peak ac Input Impedance ..... 75 megohms +/-25 megohms Division Ratio ..... 1000:1 Accuracy DC to 500 Hz ..... +/-1% 500 Hz to 1 kHz ..... +/-2% Above 1 kHz ..... Output reading falls. (Typically, -30% at 10 kHz)

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